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**BUILDING RESILIENCE TO WATER
BASED RISKS: THE CHALLENGES OF
INSTITUTIONAL ARCHITECTURE IN
METROPOLITAN SÃO PAULO**

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**Building Resilience to Water Based Risks:
The Challenges of Institutional Architecture in Metropolitan São Paulo**

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Introduction

Climate change and its potential effects are increasingly important concerns to the scientific community, governments, international organizations, and exposed populations around the world. In a number of cases these changes introduce very new scenarios whilst in others they may aggravate or even turn catastrophic already vulnerable settings. This is the case in many of the large metropolitan regions in Latin America. Here, a lack of consistent urban planning, difficulties in providing effective low cost housing as well as gaps in public services and infrastructure has led to the widespread presence of self built settlements, many of which – in turn – have had little option other than to occupy unwanted and often hazard prone areas. From country to country, these self-designed urban solutions have taken place during different time periods and have often resulted in in settings in which very different urban insertions can be found alongside each other. This does not only apply to the photographic contrasts between elite high rise buildings and their precarious, tightly packed and self built surroundings, but also to what have been called the “inner burbs” those largely self-constructed areas that have become the new intermediary suburbs, with stable communities and forms of housing renovation that have attempted to adapt the original small plot with two rooms, a kitchen and a bathroom, to the demands of new generations of family members¹.

As adaptations have taken places, flat roofs – a key asset – have enabled rooms and floors to be added on, sometimes with outside staircases, sometimes free standing and sometimes anchored on a neighbor’s wall. Sometimes the areas are flat, but in many cases they go up the side of hills, where land is cheaper or where public land has been invaded. Here within

¹ Peter M. Ward, Edith R. Jiménez Huerta, & Maria Mercedes Di Virgilio, (2014) Housing Policy in Latin American Cities: a New Generation of Strategies and Approaches for 2016 UN-HABITAT III. London: Routledge (2014)

the apparent similarity can be found very different patterns of land-use and land ownership, as well as many visible and invisible hazards due to the patterns of land occupation. A street of brightly painted three or four floor houses, with balconies and flowers, may well hide a small stream with precarious infill housing built on top of raw sewage and subject to raging floodwater invasions at certain times of the year. Equally, the side-by-side houses, terraces and flat roofs, growing up the side of a hill may be hiding numerous hidden dangers of land erosion and water infiltration, as well as the simple mechanical consequences of excessive weight, angle of pressure and lack of resistance. Taking the nine major Brazilian metropolitan regions as a set, it is estimated that within them some 1.7 million families are without adequate housing; a figure that has grown in recent years in areas such as Belo Horizonte, Curitiba and São Paulo at over 15% a year.

Vulnerability in these circumstances is not merely material and social, but also institutional. Meeting the challenge of living with these kinds of risks is not something that should be seen as a responsibility that local communities have brought on themselves. In area after area, both the national and local state has ignored self-built housing: at best because of recognizing its own incapacity to meet the challenge, at worst as a direct consequence of a highly unequal society. The absence of the State in land use demarcation and regulation has also been mirrored, until very recently, in the highly unequal distribution of key agencies both in service provision and maintenance.

The consequences of such setting for a more democratic state seeking to be more responsive to the population as a whole and to introduce a minimum of equity into public affairs are immensely difficult. To take one example alone, in the municipality of São Paulo whose population is currently 11.3 millions, the estimates of housing deficit are around 7% of dwellings (230,000 units as recently calculated) and the number of families without adequate housing has grown by 18% from 2011 to 2012. Looking at the criteria for inadequacy, the problems most visible are excessive density, lack of infrastructure and problems with land titles. The same pattern is repeated throughout the São Paulo metropolitan area. Land title issues are an old but increasingly crucial problem, as the work of the Latin American Housing Network also found (Ward et al 2014). Some 30 years on from the original land purchase, at times with nothing more than a piece of paper noting the names of seller and buyer, house prices have risen, new generations need to use family assets and are finding that bank loans are impossible without deeds and other documents.

Perhaps most important of all in looking for solutions in the midst of such complexity, is the

gradual recognition by public agencies that those living in such circumstances are also very much in favor of urban improvement, of land re-use, sustainable development environmental controls and public offers of housing, but they are highly resistant to the traditional solution of large housing estates built on the outskirts of cities and metropolitan areas. On the contrary, they and their children and grandchildren identify themselves with where they live and their neighborhoods, many of which have highly descriptive names, create a mosaic of local reference points. They may often be a long way from work, but are certainly nearer than the out of town sites and, internally are increasingly offering other commercial prospects.

Whilst the focus of the paper is on water borne hazards, especially flooding and land slippage, this should not be taken to imply that this is the limit of our programmatic concern. These large urban areas are facing many challenges independently of climate change; others are indirectly affected or have aggravated existing climate patterns. In places like the São Paulo metropolitan area, excessive horizontal building and uncontrolled urbanization has created a concrete floor that increases local temperatures, affects rainfall and is unable to deal with the resultant downpours even in areas where land slippage and housing deficit does not exist. Equally, these different questions move and connect with other complex issues, such as health and environmental sustainability. Climate change adds an extra layer and in certain cases appears to be producing unforeseen jump shifts in existing patterns². In focusing on water borne hazards we are conscious that this is only the more visible tip of the iceberg, but as our comparative look will show it is sufficient to generate considerable concern for the response capability of our existing approaches to institutional architecture and governance.

² IPCC, Working Group II, Fifth Assessment Report “Climate Change 2014: Impacts, Adaptation and Vulnerability,” Chapter 27. Central and South America.”http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap27_FGDall.pdf. See Box 27-2, Vulnerabilities of South American Megacities: The Case of the Metropolitan Region of Sao Paulo, p. 27.

The comparative question

Climate change and weather patterns as public authorities constantly find out, do not respect governmental jurisdictions and Greater São Paulo, one of the largest metropolitan areas in Latin America³, is no exception. Within it, a significant part of 39 municipalities and a population of over 20 million share the same broad hydrographic water basin⁴ as well as a number of smaller sub basins, in which both up-stream and down-stream issues of water management are present as well as their consequences (see figure 1, below). Given that the physical, social, economic, political, and environmental factors of an area are all aspects that can affect its vulnerability – that is, its susceptibility to damage - its adaptive capacity will depend on the ability of governments, other interested organizations, and individuals to prepare for and respond to hazards. In the great majority of cases, this challenge goes beyond that of a single government, either as jurisdiction or – in the Federal case – level. How can and do different agencies, authorities, levels of government, civil society organizations and – as we will see – community based organizations work together to build urban resilience? Similar questions can be developed for most of the larger individual municipalities that are within the greater São Paulo metropolitan area. São Paulo itself, with over 11 million inhabitants is a huge and complex setting where problems of inter-agency coordination and a lack of effective territorial based decentralization exacerbate existing vulnerabilities, even without climate change. Figure 2 shows the hydrographic map of the São Paulo municipality which, for all effects and given the high levels of urban density, is for many of its residents totally unknown and certainly not visible in the day to day.

³ We use the expression metropolitan area to refer to the greater São Paulo conurbation rather than raise questions about the Brazilian legislation on Metropolitan Regions.

⁴ The Upper Tiete River Basin (Bacia Hidrográfica de Alto Tiete)

Figure 1: The Upper Tietê Hydrographic Basin and the 39 municipalities of the São Paulo Metropolitan area

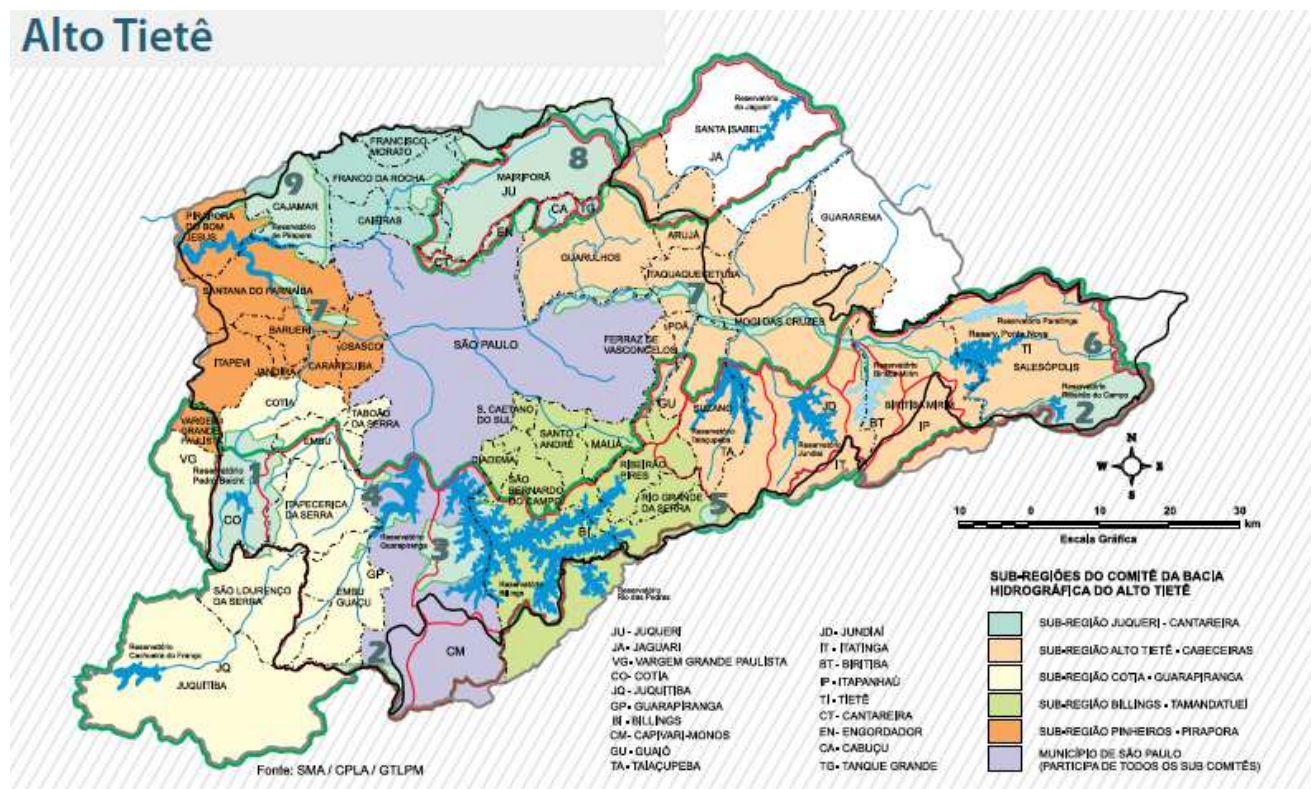
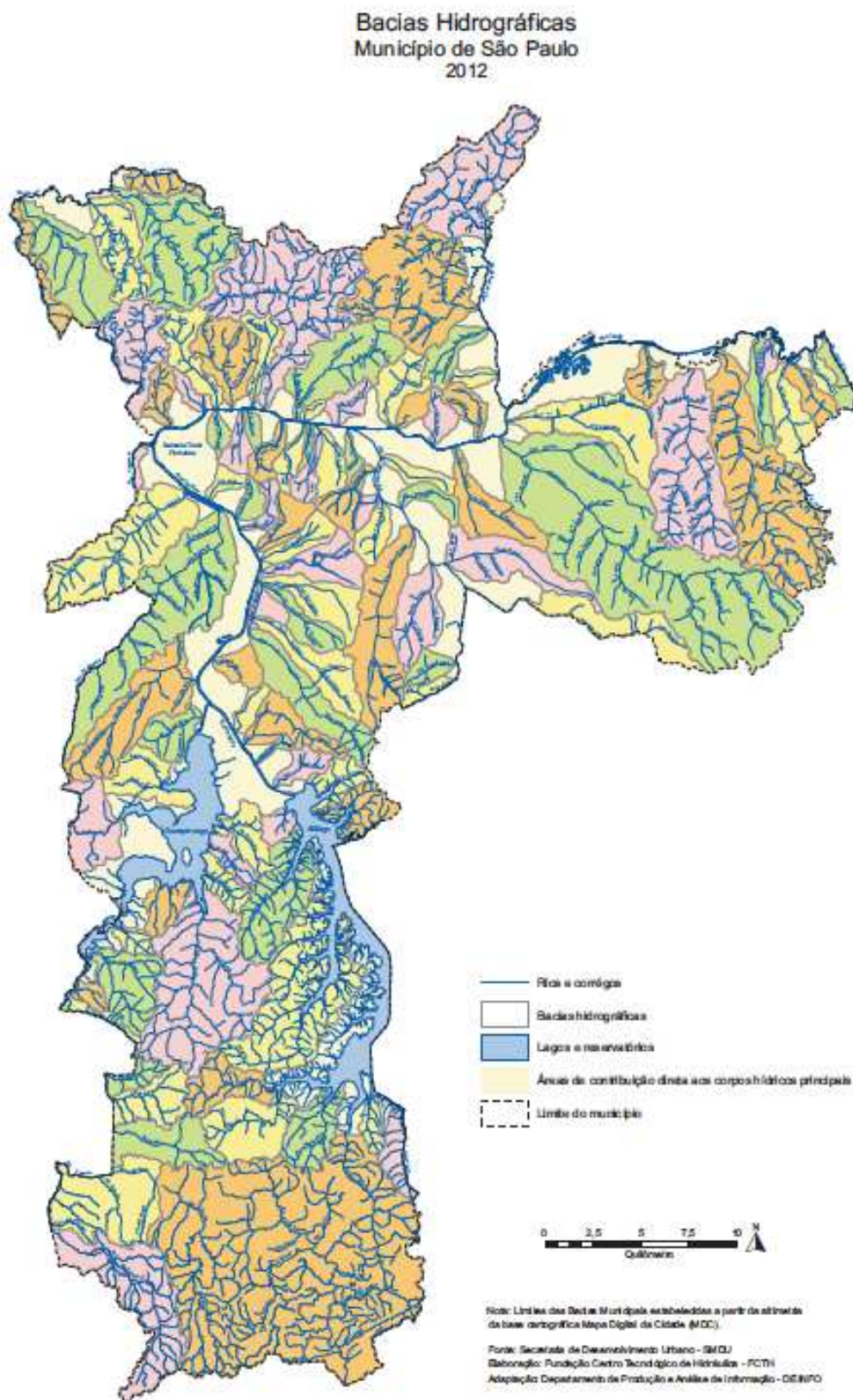


Figure 2: Hydrographic Map of the Municipality of São Paulo



This empirical question of how to build effective resilience in settings which are socially, materially and institutionally vulnerable – which also applies to a number of Latin American

countries and large conurbations – gains an extra dimension in the Brazilian case as a result of the newly formulated National Civil Defense Policy (2012), which proposes the multi-jurisdictional hydrographic basin as a key to water based dangers. Furthermore it calls for an integrated approach to public policies for land use, territorial and urban development, health, environment, water resources, geology, infrastructure, education, science and technology in order to promote sustainable development. Could this provide an important contribution or even the institutional architecture for increasing the priority for prevention and helping to develop more resilient cities?

To try to answer this question from within the Brazilian case itself would be an exercise in futurology. The national policy and its organizational component (the National Civil Defense System) are so recent that any possible effects are merely guesswork. At municipal, state and Federal levels, the cycle of open access Civil Defense Conferences in which civil society groups joined public sector workers and the civil defense staff in debating key issues in prevention and implementation only took place in the first semester of 2014. Our own work on metropolitan governance within the Federalist countries of the Americas also provides little help. Metropolitan governance as such – independently of the area – is still a long way off reaching any degree of effectiveness, let alone of creating new democratic spheres where key interurban issues can be discussed ⁵.

In the specific case of Brazil, there has been a steady growth in inter municipal consortia, but again these have tended to move down more easier paths of joint health service provisions than facing the difficult and more conflictive issues of conurbation planning and sustainability⁶. We have therefore adopted a different approach, that is, to draw on a recent study of public sector coordination and preparedness in ten large African cities most of which have very similar aspects in terms of urban occupation and land use and, as will be shown, also have many water-based challenges⁷. This enables us to develop a series of partial findings and questions, which we then apply to the case of metropolitan São Paulo as currently constituted. Unfortunately, anticipating the conclusion, the findings from the comparison with São Paulo show that without the creation of incentives generated through

⁵ Peter K. Spink, Peter M. Ward. & Robert H Wilson (2012) *Metropolitan Governance in the Federalist Americas: Strategies for Equitable and Integrated Development*. Notre Dame, Indiana: University of Notre Dame Press (2012). See also for the Brazilian case the special number of *Cadernos Metrópole* (vol 11 number 22, 2009) on *Gestão Metropolitana*.

⁶ *Município e Estados: Experiências com Arranjos Cooperativos*. Cadernos Adenauer, 12, 4, 2011

⁷ Robert H Wilson and Todd Smith, co-directors. "Urban Resilience to Climate Change Challenges in Africa," *CCAPS Working Paper No. 4* (Austin: Robert S. Strauss Center for International Security and Law, May 2014).

intergovernmental linkages, local governments will be unable to overcome the spatial mismatch of governmental jurisdictions and the footprint of flooding. Equally it shows that on a world-scale, there is little to be optimistic about.

The paper begins by laying out the general discussion on resilience and climate change, with special emphasis on water born hazards. It then presents the results of the African study and the proposals generated before going on to apply these to the existing organizational and institutional structures of inter-jurisdictional coordination in metropolitan São Paulo.

Introducing the dynamics of climate change: resilience and vulnerability

The policy domain of climate change is complex, both with respect to climate change science, projected impacts, and to the governmental/institutional framework for policy discussions and actions. The terminology used in climate change policy discussions is also complex, and practitioners and scholars often disagree over the definitions of such important terms as resilience and adaptation. The term resilience has come to be increasingly used in policy discussions,⁸ even though disagreements exist over its precise meaning, at least in academic communities.⁹ The term resilience has a connotation of a system “bouncing back” (echoing a return to equilibrium in ecological systems or a material regaining shape following a perturbation, as in material sciences). One source of criticism of the use of the term in developing countries is that the pre-climate event status quo, especially the low socio-economic characteristics, is unacceptable and, therefore, building resilience should be framed as an issue of development and transformation of social conditions.¹⁰ In other words, traditional efforts to improve social and economic development must not be displaced by initiatives that improve resilience without, simultaneously, improving socio-economic conditions. The term resilience is subject to ongoing debate, but it has gained widespread use

⁸ Peter Newman, Timothy Beatley, and Heather Boyer, *Resilient Cities: Responding to Peak Oil and Climate Change* (Washington, D.C.: Island Press, 2009); Fatima Shah and Federica Ranghieri, *A Workbook on Planning for Urban Resilience in the Face of Disasters: Adapting Experiences from Vietnam's Cities to Other Cities* (World Bank, 2012), <https://openknowledge.worldbank.org/handle/10986/2235>; UNDP, UNCDF, and UNEP, “Local Governance and Climate Change, A Discussion Note” (The United Nations Development Programme, United Nations, December 2010), <http://www.snap-undp.org/elibrary/Publication.aspx?ID=447>; *Local Environment: The International Journal of Justice and Sustainability* (Special Issue, forthcoming).

⁹ Siambabala Manyena, “The Concept of Resilience Revisited,” *Disasters* 30, no. 4 (December 2006).

¹⁰ Mark Pelling, *Adaptation to Climate Change: From Resilience to Transformation* (London: Routledge, 2010).

in policy and research communities concerned with climate change adaptation in urban areas.¹¹

The United Nations International Strategy for Disaster Reduction (UNISDR) defines resilience as “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.”¹² Adaptation is defined as “the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.”¹³ As these are the definitions largely adopted by key public sector actors, including the Civil Defense, and any discussion of these would go beyond the scope of the paper, we will adopt these with the understanding that in practice they are highly interdependent concepts. In other words, building resilience in the face of climate change refers to the ability of communities and cities not only to respond to and absorb the effects of individual potentially disruptive weather-related events, but also to sustain this ability in the face of climate change that may increase the frequency or intensity of such events in the future.

Weather patterns generate different types of hazards as well as different levels of exposure in specific geographies. Increasing atmospheric temperatures are projected to shift the frequency, intensity, duration, and timing of storms worldwide and generate greater intra-annual variation in precipitation and lead to sea level rise. Heavy but short precipitation events mean that the same areas that are subject to flooding can also be subject to drought. Increasing temperatures and elevated atmospheric temperature are projected to shift the frequency, intensity, duration, and timing of storms worldwide.

In the Brazil case, recent independent assessments point to a serious decrease of water resources in the semi-arid and arid North Eastern region, leading to vegetation change and species extinction whilst the southeast will suffer significant increases in rainfall, affecting crops, land use and increased intensity and frequency of flooding. In the central savannah

¹¹ Peter Newman, Timothy Beatley, and Heather Boyer, *Resilient Cities: Responding to Peak Oil and Climate Change* (Washington, D.C.: Island Press, 2009); Fatima Shah and Federica Ranghieri, *A Workbook on Planning for Urban Resilience in the Face of Disasters: Adapting Experiences from Vietnam's Cities to Other Cities* (World Bank, 2012), <https://openknowledge.worldbank.org/handle/10986/2235> UNDP, UNCDF, and UNEP, “Local Governance and Climate Change, A Discussion Note” (The United Nations Development Programme, United Nations, December 2010), <http://www.snap-undp.org/elibrary/Publication.aspx?ID=447>; *Local Environment: The International Journal of Justice and Sustainability* (Special Issue, forthcoming).

¹² UNISDR, “Terminology,” *UNISDR*, n.d., <http://www.unisdr.org/we/inform/terminology>.

¹³ UNISDR, “Terminology,” *UNISDR*, n.d., <http://www.unisdr.org/we/inform/terminology>.

(*cerrado*) it is estimated that the increase in temperature will result in the extinction of 38-45% of plants and that there will be considerable reduction in staples such as beans (50%) and soya (25%)¹⁴. The situation in Africa shows many similarities of extremes. Although much of Africa will actually have less precipitation, the intensity of storms is projected to increase. This means that extreme heavy rainfall that previously occurred once every 20 years will now occur once every 15 years.¹⁵ Looking at specific regions of the continent, there are projections for increased precipitation in areas of western Africa and eastern Africa, concentrated during current heavy-rain periods, which increases the chance for flooding, without improving the availability of water during the dry seasons.

Researchers have also identified increased frequency of heavy rain events in many southern African nations.¹⁶ Coastal areas are especially subject to flooding as a result of both precipitation events and sea level rise. An estimated 54 million Africans live in vulnerable Low Elevation Coastal Zones (LECZ), defined as areas 10 meters or less above sea level.¹⁷ Areas around rivers and creeks are also susceptible to riverine flooding, though localized flooding occurs outside these areas as well, especially in more heavily developed settings. By way of comparison, any quick look at an atlas in Brazil will show how much of its population has until very recently been located along its extensive coastline and how key this is to many of its social and economical activities.

Amongst the many different aspects of climate change which require focus from the standpoint of inter-agency coordination and governance, flooding stands out for the immediacy of its actions and consequences – often highly unpredictable when coupled with land slippage and other forms of erosion. Drought has other consequences as does the rise of sea levels and during time the effects may well be much more catastrophic and the distinction made has more to do with certain key characteristics. Whilst it is possible to say that a decrease in rainfall will lead to a significant change in the semi-arid region of Brazil

¹⁴ Preparatory Report of the Brazil Panel on Climate Change and Report from World Wildlife Foundation. See also Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report. <http://www.ipcc.ch/report/ar5/wg1/>.

¹⁵ *Managing the Risk of Extreme Events and Disasters to Advance Climate Change Adaptation* (Cambridge, UK: Cambridge University Press, 2012), 7, 25, 143.

¹⁶ M. Boko et al., “2007: Africa,” in *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment of the Intergovernmental Panel on Climate Change*, ed. M.L. Parry et al. (Cambridge UK: Cambridge University Press), 443 – 444, http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm.

¹⁷ *Migration and Global Environmental Change: Future Challenges and Opportunities* (The UK Government Office for Science, London, October 2011), <http://www.bis.gov.uk/assets/foresight/docs/migration/11-1116-migration-and-global-environmental-change.pdf>.

(covering a significant part of eleven states) it is not possible to say, for example, which if not any or all of the already identified at risk areas for rainfall induced land slippage in São Paulo will in fact disappear overnight in a sudden thunderstorm that might have fallen instead on the hillsides beyond Rio de Janeiro. (In January 2011, the reverse actually happened when a storm front that passed over São Paulo caused havoc and nearly 300 lives lost in landslides and mudslides in the hill towns of Rio de Janeiro). Flash flooding is not unusual in Brazil and there are many reported cases of major scale disasters, especially in the last 50 years when reporting has been more consolidated (over 3,250 fatalities between 1965 and 2005)¹⁸. In this sense, in terms of climate change, sudden flooding and rain-storms are relatively unique as both a fast-onset, localized and extremely aggressive hazard. For São Paulo, responsible for a significant share of GDP, economists have calculated the yearly effect of normal flooding – not counting land slippage and other events - along its linked productive chains as some USD 350 million in normal years.¹⁹

Human created sources of vulnerability in comparative perspective

The impact of weather-related hazards is related to a location's degree of exposure to a hazard (e.g. high elevations are not exposed to sea level rise) and to the level of vulnerability at that location. In other words vulnerability will vary by hazard type and by geographic location. Within the basic characteristics of the location – for example the broad water basin within which metropolitan São Paulo is located as also the cities in the African study - deficiencies in land use and transportation planning, infrastructure, drainage, and sanitation will exacerbate vulnerabilities. Growing populations further strain urban services, including drainage, waste collection, and disaster response systems, that are crucial elements for resiliency. If drainage pipes and channels are too small or non-existent, relatively minor precipitation events can lead to flooding. Even with sufficient drainage systems, inadequate waste management can result in trash blocking the flow of water.²⁰

Both in the case of the African cities studied and many similar large conurbations in Brazil (for example São Paulo, greater Belo Horizonte and metropolitan Rio de Janeiro where

¹⁸ F.R. Nogueira. Gerenciamento de Riscos Associados a Escorregamentos: Contribuições às Políticas Públicas Municipais para Áreas de Ocupação de Encostas. Tese de Doutorado, UNESP – Rio Claro.

¹⁹ Eduardo Haddad & Eliane dos Santos: Economic Impacts of Natural Disasters in Megacities: the case of floods in São Paulo (in press: Habitat International).

²⁰ I. Douglas et al., “Unjust Waters: Climate Change, Flooding and the Urban Poor in Africa,” *Environment and Urbanization* 20, no. 1 (April 1, 2008): 187, 192.

flooding and or land slippage are very current dangers), these additional vulnerabilities are further accentuated by poorly regulated urban development. Often, even though land just beyond the periphery of cities is being converted to urban uses, the housing supply cannot keep pace with the population increase. Growth pressures lead to settlements in areas previously deemed unfit for development, such as on wetlands, in floodplains or natural drainage corridors, and on sandy soil with foundations that may be swept during flood events, thereby aggravating existing vulnerabilities. Zoning regulations may prohibit settlement and development in vulnerable areas but are too often not enforced²¹. Paving over previously permeable natural areas will also disrupt the natural absorption of water, and if development occurs over river and creeks, it can block natural outlets for water and create regular flooding.

To make matters worse, management of drinking water resources is increasingly acute in cities both in terms of supply of water and its distribution to growing urban populations. Much of the burst in rapid urbanization over recent years has not been followed by increases in the sources for water supply and catchment. Inefficient water distribution systems and inadequate water storage capacity lead to the inefficient use of precipitation. Even though climate change scientists are reluctant to attribute specific effects of climate change on water resource availability due to natural variability in precipitation, governments are fully aware that the rapidly growing demand for water due to high population growth and economic development has the potential to exhaust scarce resources. In sum, both water management policies and quality of infrastructure have significant effects on water stress and scarcity.

Despite the increasing interest and attention being devoted to climate change adaptation, the topic rarely is formalized in policies and plans of local governments. A local government's decision to engage in policymaking or planning for climate change adaptation is affected by that government's authority to make such decisions, resource capacity, the political context, and demands and needs of the city's residents. In the cities studied here, we find that climate change adaptation is generally not a high priority for local governments, although most are concerned with disaster response and risk management for flooding.

Responsibilities for policies addressing scarcity, water production in particular, generally fall to national or state/provincial level governments and single purpose water resource management agencies rather than local governments; a local government at the mouth of a

²¹ UN-HABITAT and UNEP, *The State of African Cities: Governance, Inequality, and Urban Land Markets* (Nairobi, Kenya: UN-HABITAT, 2010), 29, <http://www.unhabitat.org/documents/SACR-ALL-10-FINAL.pdf>.

river has little influence on water management upstream. The same can apply to broad water catchment areas that span multiple jurisdictions. Across the range of governmental organizations that are potentially affected by climate change, water resource management agencies are somewhat unique in that the water scarcity hazard directly affects long-term water resource security but this slow-onset hazard can be effectively addressed through long-term planning. Local governments may have influence over local water distribution systems and can encourage water conservation, which are important resiliency measures in their own right.

Finally, it is important to recognize that local governments, generally resource-constrained, are faced with many pressing problems. Prioritizing adaptation efforts for slow-onset hazards, such as water scarcity or sea level rise, ahead of other immediate needs in local government decision-making is difficult even when considering the long-term consequences. If hazards result in an immediate impact, as in flooding, local governments are more likely to be motivated to address them, even though these actions may not necessarily be framed as climate change adaptation.

All these different features are often – if not always – framed by the mismatch between the institutional geography of local government jurisdictions and the broader geographic footprint of hazards. For the public works department of a large city seeking to get ready for the rainy season, attention will be turned to specific roads, low lying areas and the drainage clearance. For the soon to be approaching weather system that will slam a cold front into a highly charged and over heated conurbation, it is all just a huge piece of land and sea on which to rain down. For the hills, hillsides, rivers and very often hidden streams behind the dense urban and con-urban landscape – some of which are performing “natural” jurisdictional distinctions – it will mean being in the middle of the sandwich without knowing what will give – this time. This then is social, material and institutional vulnerability at its most chaotic and as the description shows one of the big issues is to effectively and metaphorically learn the languages that the different actors are using.

Forces shaping the resilience agenda in African cities

Among the ten large Africa cities examined in the Wilson and Smith (2004) study²², only two local governments, Cape Town and Johannesburg, had formally adopted climate change

²² See note 7

adaptation policies. In the other six cities, climate change adaptation has not been formally integrated into local government initiatives. But in all ten cities, a range of local government functions, such as disaster response, water resource planning, and urban development management, are affected fairly directly by weather hazard impacts. In this section, the factors, including the national policy context for climate change policy and the levels and types of authorities vested in local government, that help explain the various approaches taken by local governments to climate change adaptation policy are presented.

National adaptation policy context

The introduction of a climate change adaptation agenda in developing countries has been encouraged through international efforts through such mechanisms as obligation under international conventions and technical and financial assistance for specific activities. Under international influence, the adaptation agenda generally first emerges at the national level, as indeed the case in the countries studied here. National governments engaging in climate change policy must make decisions regarding priorities to place on mitigation, adaptation, and disaster risk management as well as balancing these with other existing national priorities.

Organizational Structure and Authority of Local Governments.

Local governments are embedded in national governmental systems and given the relatively centralized nature of the countries studied here, with the exception of South Africa, the roles and capacity of local governments are affected by the nature of central-local government relations. Even though most of these countries have attempted to decentralize their administrative and fiscal systems. The structures of local governments themselves are often fragmented. In Dar es Salaam, three municipal counties, a city council, and at least nine ministries have jurisdiction over climate change issues, and coordination among these different bodies is both limited and inefficient. In the absence of strong local government institutions, adaptation efforts must rely on the international organizations, national governments, or even NGOs. Disaster risk management and response also is centralized in most countries, with NGOs playing primary roles in response to local flooding in a few cities. Local government in the two cities in this study with formal adaptation policies, Cape Town and Johannesburg, had relatively high capacity due in part to the relatively high level of national development.

The question of the capacity of local governments to address climate hazards has an important spatial component. Local governments face a variety of climate change hazards, and each hazard has a unique geographic scale. Flooding is a localized phenomenon affecting low-lying areas of a city. In contrast, the issue of water scarcity, by its very nature, must be considered at scale beyond the jurisdictional boundary of an individual city. Thus, for some hazards, intergovernmental cooperation is essential for effective action, as illustrated by the creation of river basin agencies in Morocco. Rather than dividing water control and management on the basis of local government administrative boundaries, new agencies were created at the basin level. This ensures that the administrative unit corresponds to the geographic scale of water scarcity. Johannesburg is in a similar situation in which a parastatal organization, Rand Water, in collaboration with the national government agencies of South Africa, Department of Water Affairs, and Lesotho, is responsible supplying the city and surrounding region with water through a grand inter-basin transfer scheme, the Lesotho Highlands Water Project. Johannesburg, therefore, does not have authority to integrate climate change projections into water planning and has very little power to implement adaptation beyond water conservation efforts within the city boundaries.

Two other solutions to the mismatch of governmental jurisdictions and hazard footprint were identified. A central government can force local governments to collaborate or local governments can be geographically restructured to allow for closer alignment of administrative boundaries and the hazard footprint. In Cape Town, six municipalities were consolidated into a “unicity”, a single metropolitan entity. This may have helped to establish a more efficient local government, but also more effective management of climate change hazards.

Given these structural impediments facing local governments to mobilize resources in response to these complex hazards, networks of actors, governmental and nongovernmental, have emerged at the city level. These are particularly notable in the context of informal settlements, where local governments are unable or reluctant to act. Informal settlements, by definition, have developed outside the institutional and legal framework of local authorities, often the lag between the development of formal housing and the extension of government services and population growth, as discussed above. Local authorities may view these communities as illegal and refuse to recognize a municipal responsibility to deliver services in these areas. These inadequacies generate tensions between local government and populations in the settlements but a range of cases illustrates strategies to reduce these

tensions. Nongovernmental actors may provide an alternative especially in terms of mobilizing the residents in informal settlements, who tend to be quite vulnerable to hazards, as discussed above.

Urban Planning

Urban planning and infrastructure provision significantly impact the level of vulnerability, and ineffective planning in the past has created a legacy of exacerbated vulnerabilities, as discussed above. Several issues to explain ineffective planning can be observed in these cities. First, developers may disregard urban planning and land use regulations and build in areas that are vulnerable to climate change hazards with or without the tacit approval of local regulators. Second, control exercised by higher-level governments can compromise the ability of local government to implement initiatives. Third, competing priorities and agendas may cause local governments to disregard urban planning controls.

Urban planning in informal settlements faces multiple challenges, which at the core relate to limited authority to provide services in informal settlements and the weak political voice of residents. The types of services missing or provided in a limited bases include, unenforced building codes, narrow roadways leading to inadequate public transportation and fire services, and inadequate infrastructure and poor maintenance. In addition, due to both migration and natural growth, the populations of informal settlements are expected to grow throughout Africa. This will undoubtedly place an even greater strain on the limited resources of local governments.

Given the very high levels of rural-urban migration and growth of informal settlements, several cities, have attempted to relocate informal settlement populations to less vulnerable areas of the city. Many of these relocation plans, however, result in further displacement from the economic opportunities of the core business districts. Given the uncertain quality of surrounding infrastructure, this can pose an additional burden on the local population when they need to access services in the city center. Furthermore, the residents of these informal settlements are often distrustful and skeptical of government initiatives. Relocation efforts by the government, based on sound judgment of vulnerabilities in existing informal settlements, have produced mixed results.

On a more positive note, the need to improve urban planning is frequently recognized and notable efforts to enhance the authority and capacity of local planning agencies are underway. For example, the local government in Cape Town approved a municipal

densification policy in 2012. The policy aims to encourage more sustainable and efficient planning and land use. In Luanda, the central government recognized that unregulated growth and a lack of policy initiatives made the city more vulnerable to climate change hazards. Therefore, the central government developed new agencies within Luanda's provincial government to create comprehensive urban master plans.

Setting Local Policy Priorities

The decision to engage in policymaking or planning for climate change adaptation by a local government will be affected by its defined authority and resource capacity and subject to the range of needs faced by the local population and political pressures. Limited resources, a recurring constraint on governments, means that priorities for action across a wide range of needs must be set. Based on the case studies, climate change adaptation is generally not a high priority for local governments. At the same time, most cities are engaged in disaster risk management.

The linkages between climate change adaptation and disaster risk reduction are well understood and reflected. Given the frequency of flooding, often with devastating effects, that local governments would make flooding a policy priority is not surprising. More capable local governments, through city planning and related departments, and communities may engage in flood mitigation efforts. Unfortunately, many cities are acting primarily in a response capacity, rather than in flood mitigation efforts. Furthermore, in flood mitigation efforts cities often fail to recognize and integrate the impact of climate change on the frequency or severity of expected floods in the future. In other words, cities struggle to adequately prepare for and respond to current floods much less prepare for future floods.

Local governments are faced with many pressing and immediate problems and are resource constrained. Placing adaptation efforts for slow onset time hazards ahead of other immediate needs in local government decision making seems highly unlikely even if the long term consequences were understood. To the extent that hazards represent a present danger, as in flooding, local governments are likely to be more motivated, despite the fact the these governments are not acting for the express purpose of climate change adaptation.

Roles for non-governmental and community based organizations

Given the slow progress of local governments in addressing the impacts of hazards, local NGOs and CBOs are becoming engaged in resilience initiatives, particularly in informal settlements. For example, in South Africa, the NGO Slum Dwellers International is

partnering with local government and academia on in situ upgrading projects, including storm water drainage to improve resilience to seasonal flooding. The presence of NGOs acting in informal settlements is not surprising given the absence of effective local government initiatives in these areas. Informal settlements, by definition, have developed outside the institutional and legal framework of local authorities, often the lag between the development of formal housing and the extension of government services and population growth, as discussed above. Local authorities may view these communities as illegal and refuse to recognize a municipal responsibility to deliver services in these areas. These inadequacies generate tensions between local government and populations in the settlements but a range of cases illustrate strategies to reduce these tensions. Nongovernmental actors may provide an alternative mechanism for involving residents in informal settlements, who tend to be quite vulnerable to hazards, as discussed above.

In Kampala, as the local government faced resource constraints and competing priorities, NGOs have taken the initiative to develop programs that increase the resilience of vulnerable populations. In Dakar, a local NGO works directly with informal settlement residents to facilitate dialogue with the national government. In Accra, YES-Ghana, a local NGO, works in informal settlements to address waste disposal, an issue central to flooding in the city due to waste buildup in drainage ditches. In some cities, the local government has identified NGOs as potential partners. Angola's GTRUCS, an urban planning agency in local government, collaborates with NGOs in conducts community outreach to implement its programs. The absence of effective networks incorporating community-based or nongovernmental organizations, as in Alexandria and Casablanca, can impede effective resilience planning and implementation.

A case that is particularly instructive of the potential role of NGOs in securing collaboration across multiple actors is seen in an urban-agricultural partnership developed in response to flooding in Dakar. UrbaDTK, a local NGO, argued that flooding was less related to heavy rainfall than to the decision of city officials to end pumping water from underground aquifers due to its contamination. UrbaDTK developed a multi-sector approach in which water in urban areas is sanitized and pumped to agricultural areas, thereby lowering Dakar's underground water table and increasing capacity to absorb water during rainfall. The interaction of weather events, ecological systems, and infrastructure was complex and required an innovative solution involving collaboration among multiple actors facilitated by an NGO.

The factors that help explain the extent to which local governments engagement in climate change adaptation initiatives--and the intervention of NGOs given inadequate local government engagement--include authority and resources vested in local governments by national governments, priority setting processes of local governments and, occasionally, the direct involvement of an international organization with local governments. Where a country's governmental systems is not effectively decentralized, the national government is crucial to advancing adaptation efforts, though these efforts often fall short in addressing the vulnerabilities of urban areas. Nevertheless, local governments use what the capacity and authority they have to respond especially to rapid-onset hazards like flooding, because of the immediacy of risk and the increased visibility of the consequences. The increasingly significant roles of NGOs in addressing disaster response and mitigation can provide a crucial tool if local governments can overcome poor relations in informal settlements.

Comparisons with São Paulo

As we discussed earlier, any attempt to look at the effective contribution of recent Brazilian legislation aimed at the prevention agenda and through that to sustainable development and resilience would be an exercise in futurology. However it is possible to use the broad categories and questions developed during the African cities study and to ask where São Paulo and the metropolitan area stands today. Table 1 is an attempt to do this using the principle questions and conclusions of the Wilson and Smith study.

Table 1: Large city responses to water borne hazards (Storms and Flooding) in a comparative perspective

Are Governance Systems Developing Resilience in Africa?	Current situation São Paulo
Current planning and service provision practices exacerbate vulnerability (independent of climate change)	Very similar
Rapid urban growth has placed pressure on planning and informal settlements	Rapid urban growth in the 1960s -1980s with quasi-formal and informal settlements continues to place pressure
Vulnerability will grow	Vulnerability is already increasing
Are there signs of the development of policies, plans and initiatives to build resilience to climate change in Africa?	Current situation in São Paulo
Rarely do local governments engage in policymaking explicitly motivated by consequences of climate change	Very similar
National governments both empower and impede climate change agenda setting in local governments	Climate change issues at the national level are still at the pre-agenda stage
Local government agenda setting is heavily influenced by short term needs, especially rapid onset climate hazards	Very similar
Local governments are ineffective in informal settlements, creating opportunities for NGOs and CBOs in the resilience agenda	Both local government and NGOs are ineffective in informal settlements and CBOs are forced into a reactive mode with little space for a resilience agenda
Project Conclusions	Current situation in São Paulo
“Building resilience” is rarely on the local government agenda, but signs of incipiency	There are no signs of a resilience agenda, either in these or other terms (such as prevention or vulnerability)
Complex public policy challenge	Very similar made even more complex by the absence of metropolitan governance in the water basin area
Competing local priorities and limited capacity	Competing local priorities and lack of effective decentralization and local coordination at city level make little use of capacities present
Partnerships and collaboration are required, but add further challenges	Very little experience of effective partnerships and collaboration

Conclusions: managing a complex agenda

Climate change is affecting both human and natural systems. Developing concrete, actionable policies to address the resulting challenges presents a formidable task to both national and local governments. Adaptation efforts need to take into account a range of exposures, each with varying impacts and uncertainty around frequency of events and each affecting a different set of government functions. Furthermore, the impact of one hazard can be affected by other hazards; sedimentation derived from flooding can later affect river flows and contribute to water scarcity. Current urban development practices and behaviors found in local populations can actually exacerbate vulnerabilities. Even though these deleterious

effects of current practice are known, establishing a policy framework that accounts for the diversity of the challenges and integrates new policy concerns into existing governmental structures and policy systems is daunting.

A climate change adaptation agenda can be assigned to a new governmental organization, such as a new ministry in the national government or a new department in the local government, thus differentiating its mission from those of other governmental organizations. In assigning the climate change agenda to a single organization, the organizational mission is defined and clarified. Alternatively, the adaptation agenda can be incorporated into existing governmental organizations, such as those devoted to development, infrastructure, environmental and energy issues, and disaster risk management, a process often referred to as mainstreaming. A hazard-based approach focused on a specific hazard, e.g. water scarcity, might provide a sufficiently well defined scope to facilitate collaboration among a set of governmental organizations directly affected by the hazard. But two major management issues emerge: ensuring the prioritization of adaptation in mission-driven agencies and achieving effective coordination across agencies required to address the diverse impacts of exposures and diverse sources of vulnerability.

Competing Priorities and Capacity of Local Governments

All local governments face a host of challenges. We have focused in the discussion on those with pronounced urban profile and, within that, on a particular set - the very large conurbations. However, within different parameters and some different variables a similar analysis could be made for those extensive flood plains that give sustenance for agriculture and life in the millions of smaller settlements that can be found in rural areas. Given resource constraints, the burden on local governments to provide public services, including responding to emergencies is challenging. Local officials understandably prioritize immediate concerns, such as public health and safety, over long-term climate change adaptation efforts. The urban planning shortfalls of local governments are understood and remedial action is being taken in many cities. But the large number of informal settlements and high population growth makes it difficult to address these issues. Limited efforts by local governments to address climate change challenges result, in part, from the presence of more immediate and pressing issues on the local policy agenda. In rural areas, coming to terms with water borne disasters and the increasing waterless periods may in many cases be almost too much to take, given the lack of resources and other challenges present.

Furthermore, climate change projections are frequently uncertain, and even if they wished to, local governments face dilemmas in setting priorities when confronted with uncertainty around future events. Impending sea level rise is an illustrative example. Although forecasts of the magnitude and rate of increase are imprecise, the quality of information is improving and it is fairly certain that seas will rise in coming decades. Yet what does a well intentioned planner suggest to the mayor of a low lying township which is vulnerable not only to rising seas, but the increasing intensity of tropical storms?

Partnerships and collaboration for adaptation and urban resilience.

The organizational capabilities and resources required to address the multidimensional and complex nature of climate change impacts are not found in local government alone, but are dispersed across many governmental and nongovernmental organizations and local communities. The national governments examined in this study have tended to initiate the in-country policy discussions concerning climate change. Given the relatively high degree of centralization in Africa and the need for international organizations to maximize their influence, national governments leadership in climate change policy is eminently sensible. National climate change policies and plans, even with the presence of International Organizations, rarely include an urban component and do not recognize the unique vulnerabilities of urban areas to climate hazards, at least in the countries and cities studied here. A centralized structure may offer the potential for unified and coordinated action in moment of crisis between national and local governments in unitary systems, but do not, necessarily, guarantee effective intergovernmental coordination in the more federative model. Furthermore, it is doubtful whether a more centralized model would be effective in dealing with the highly complex and heterogeneous settings in which prevention, planning and local adaptation is essential to build resilience over time.

To this extent the Brazilian proposal to focus attention on river basin and water catchment arrangements and making clear that inter-sectorial prevention is the name of the game has accepted the nature of the challenge. The experience from the large cities of Africa – many of which are not so dissimilar to ourselves – shows what the challenge means in practice.

Given limited inter-jurisdictional authority and capacity of local governments, collaboration among a range of actors seems to be a prerequisite for promoting the resilience agenda. In the Africa study, for example, the extensive collaboration in Maputo between international organizations and NGOs was able to mobilize desperately needed resources for adaptation.

In the North East of Brazil, the 800 or so NGOs, International Agencies, Churches and University research groups that gathered together under the umbrella of the Semi-Arid Articulation (ASA) showed the potential of large scale and at time aggressive mobilization, this time in relation to drought. Can we do the same for the immense metropolitan conurbations such as São Paulo?